



Extraordinarily high conductivity at interfaces of ZrO₂:Y₂O₃/SrTiO₃ heterostructures: origin and perspective

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On the origin of the metallic conductivity at the interface of $\text{LaAlO}_3/\text{SrTiO}_3$

Y. Z. Chen, D. V. Christensen, F. Trier, N. Pryds, A. Smith, and S. Linderorth

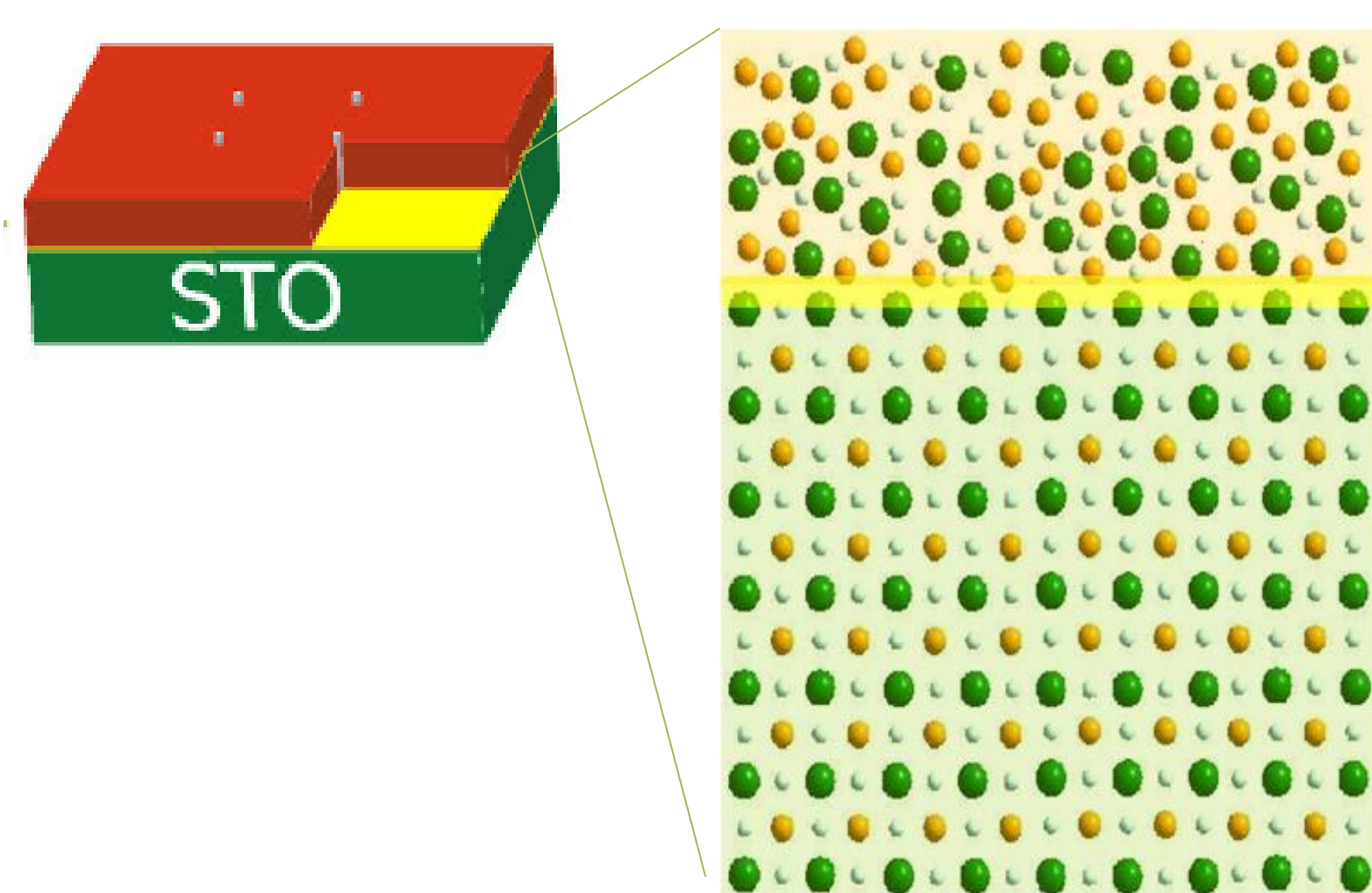
Fuel Cells and Solid State Chemistry Division, Risø National Laboratory for Sustainable Energy, Technical University of Denmark, DK-4000 Roskilde, Denmark

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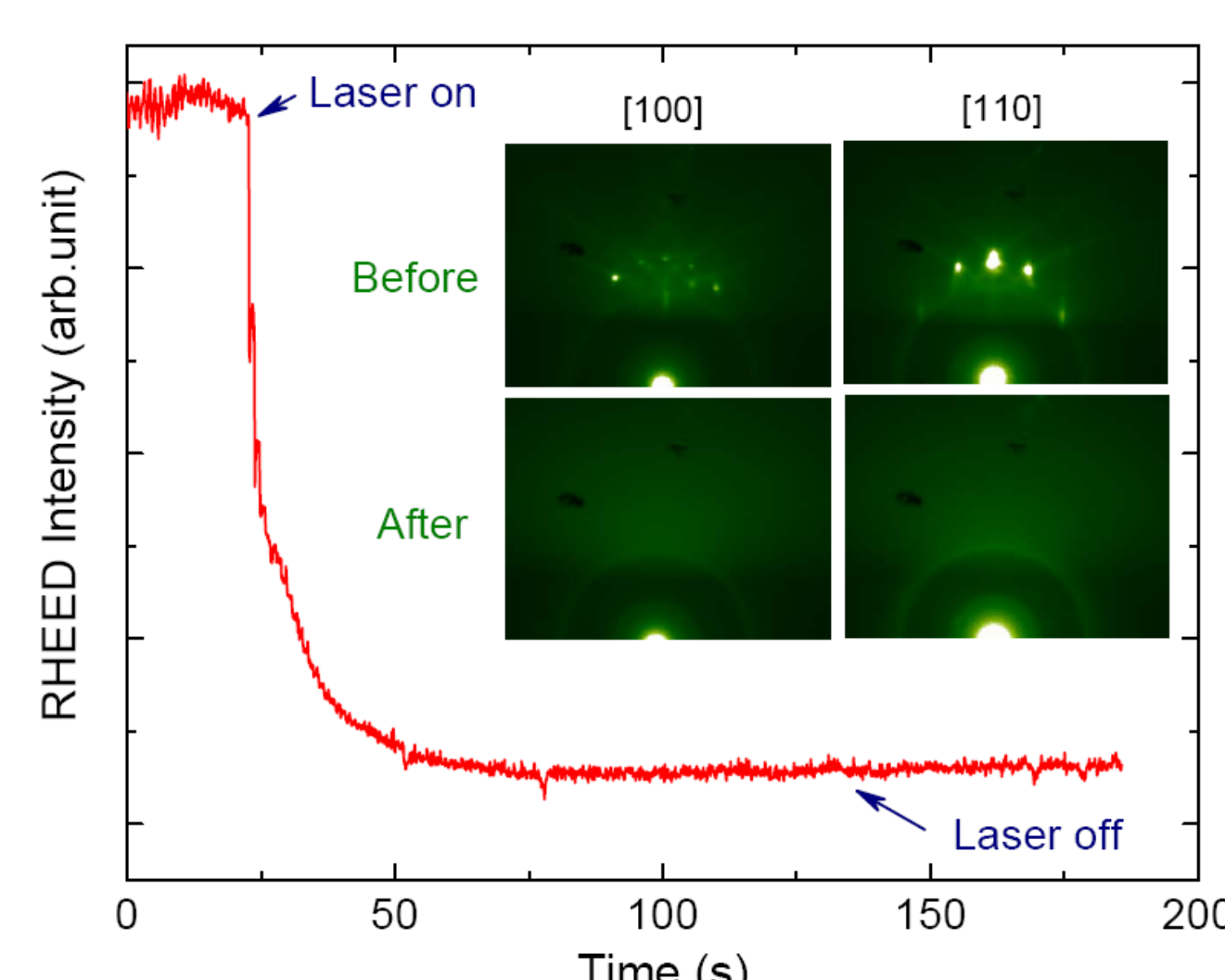
➤ Motivation:

- (1) The mechanism underlying the quasi-two-dimensional electron gas (q-2DEG) at the interface between two insulating oxides of LaAlO_3 (LAO) and SrTiO_3 (STO) remains unclear;
- (2) Whether the metallic conductivity exists in LAO/STO hetero-structures if the top LAO films are amorphous, where both polar discontinuity and cation intermixing at the interface are expected to be significantly suppressed.

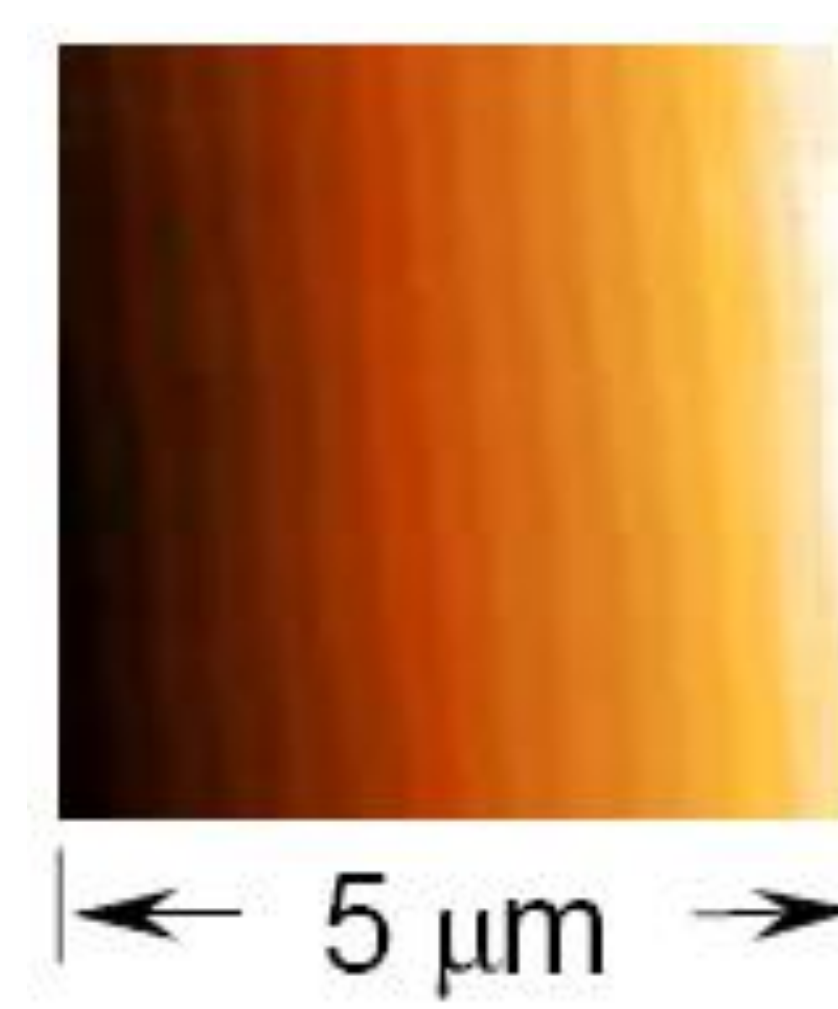
➤ Metallic and insulating interfaces in LAO/STO hetero-structures with amorphous over-layers



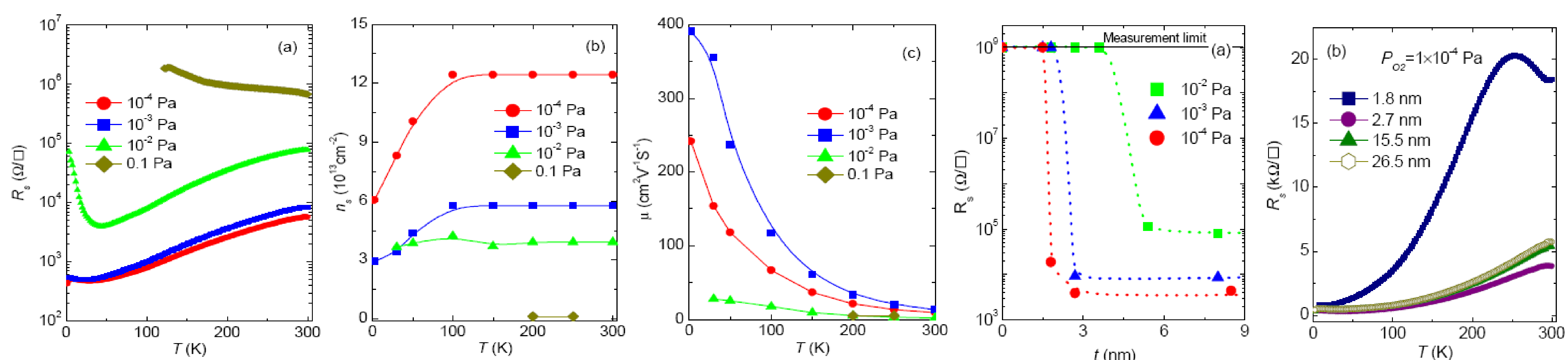
Sketch of the metallic interface



Film growth checked by RHEED

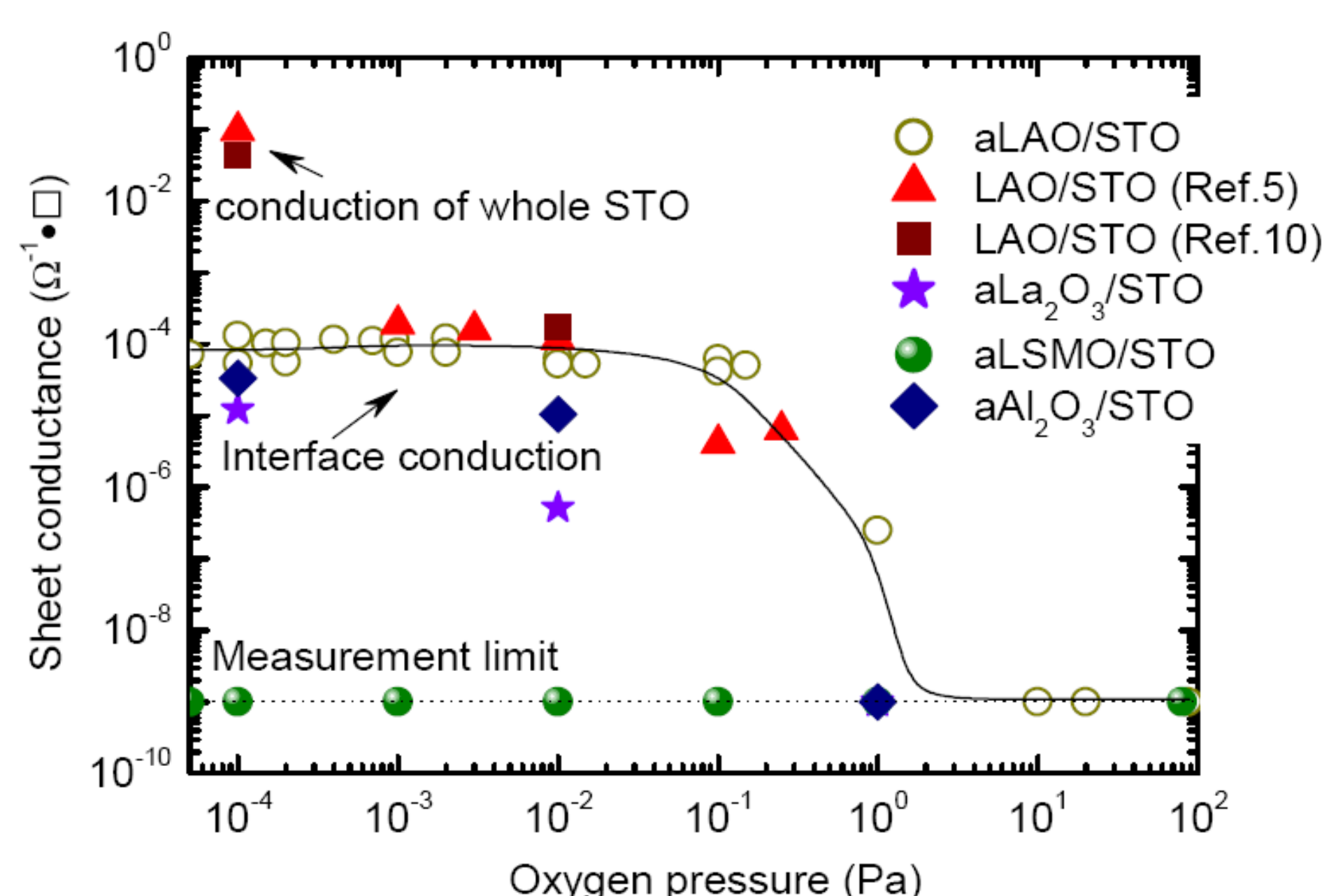


Smooth surface

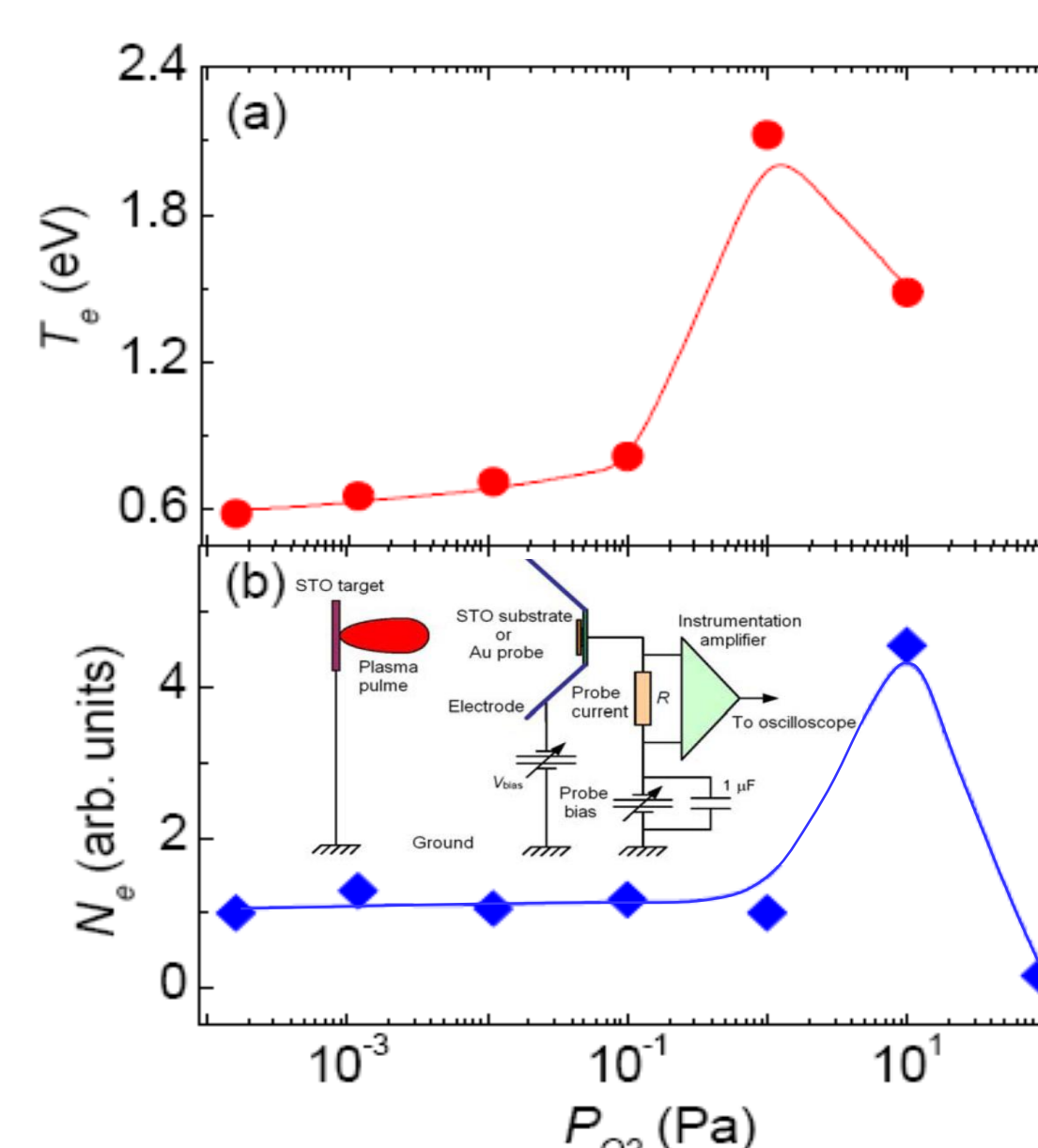


The dependence of the conductivity on the film thickness and oxygen pressure during film growth

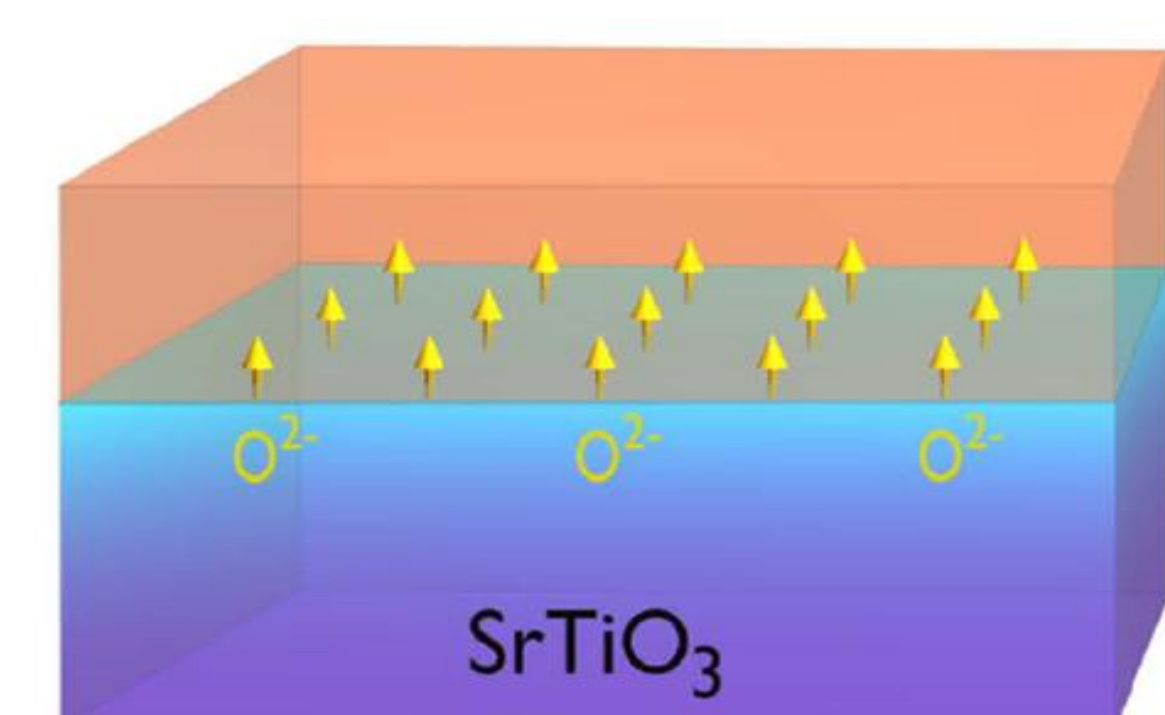
➤ Plasma composition related interfacial conductivity in STO-based oxide hetero-structures



Conductivity versus film composition



PLD plasma expansion dynamics



Oxygen ions outward diffusion

Redox reactions on STO surface

➤ Conclusion:

1. Metallic interfaces between the STO substrate and various insulating amorphous films of LAO, La_2O_3 , or Al_2O_3 .
2. Critical dependences of the conductivity on both film thickness and oxygen pressure during film growth.
3. Redox reactions on the STO substrate surface play a important role in determining the conductivity.

➤ Relevant papers

1. Y. Z. Chen *et al.* Metal-insulator transitions at interfaces of amorphous SrTiO_3 -based oxide hetero-structures (submitted).
2. Y. Z. Chen *et al.* Charge-modulated interfacial conductivities in SrTiO_3 -based oxide hetero-structures (submitted).